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The impact of R&D subsidies on firm innovation

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ABSTRACT

This paper evaluates the impact of an R&D subsidy program implemented in a region of northern Italy in the early 2000s on innovation by beneficiary firms. We use a regression discontinuity design strategy to assess the effect of the grants on the number of patent applications and the likelihood of submissions by subsidized firms. We find that the program had a significant impact on the number of patent applications, more markedly in the case of smaller firms. Our results also show that the program was successful in increasing the likelihood of applying for a patent, but only for smaller firms. Our estimates show that one additional patent application requires grants of between €206,000 and €310,000 to the firms.

1. Introduction

The need to subsidize private innovative activity is based on solid theoretical arguments dating back to Arrow (1962). According to economic theory, in the case of research and development (R&D) perfect competition is unable to maximize social welfare because the outputs of innovative activity are strongly affected by problems of non-appropriability, non-divisibility and uncertainty that prevent firms from totally internalizing the benefits of R&D investment. As a result, without public support the equilibrium level of private resources allocated to R&D ends up being below the socially optimal level (Spence, 1984).

To ensure an optimal allocation of resources for innovation, most industrial countries have public policies that support private R&D activity manly through subsidies or fiscal incentives. These policies aim to reduce the costs of the innovative outlays in order to stimulate investment in innovation. Although the empirical literature on the effects of such programs is already voluminous and growing fast, the results published to date are still mixed.

Most of the papers assess whether R&D incentives have additional effects on firms' *innovation inputs*, e.g. on investment in R&D, tangible assets or employment.[1] By contrast, micro-econometric studies of the impact of subsidies on firms' *innovation outputs* are relatively rare (see, for example, Branstetter and Sakakibara, 2002; Bérubé and Mohnen, 2009; Moretti and Wilson, 2014), although assessing the effects of public incentives on innovation outputs is crucial for at least two reasons. First, because innovation is probably the ultimate goal of most programs that support R&D activity. If the policy is able to increase firms' innovative capabilities, eventually it will also be able to raise firm competitiveness. Second, because the public program might affect innovation outputs even when keeping R&D spending or other innovation inputs constant. For example, it may encourage firms to undertake more radical projects, start R&D collaborations or improve R&D management (OECD, 2006). As a result, evaluating the effects only on innovation inputs provides a partial assessment of the impact of the incentives.

This paper contributes to this stream of research. We evaluate the impact on the recipient firms' patenting activity of a placed-based policy for innovation that subsidized private enterprises through grants. More specifically, we study the effect of a business R&D program implemented in the early 2000s in a region of northern Italy (Emilia-Romagna) on the likelihood of applying for

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[1] See, for example, the recent surveys by Köhler et al. (2012), Zúñiga-Vicente et al. (2104), and Becker (2014). On the econometric methods, see Cerulli (2010); for earlier reviews, see David et al. (2000), Klette et al. (2000) and Hall and Van Reenen (2000).

a patent, and on the number of patent applications, of recipient firms, from a sample of 612 manufacturing and services enterprises participating in the program. The Emilia-Romagna region is an important case study for our purposes: it boasts the highest patent intensity among the Italian (Nuts 2) regions, accounting for more than 10 per cent of Italian patents.[2]

We contribute to the existing literature in several respects. First, we shed more light on the effects of R&D grants on the innovation outputs of firms. This issue is largely overlooked by the evaluation literature that instead mostly gauges the effects on innovation inputs. Second, we provide evidence of the program's effects on a large sample of small and medium-sized firms – those that in principle would need to be subsidized because of their greater relative exposure to financial constraints (Hall and Lerner, 2009), and that may carry out more innovative R&D activity (Akcigit and Kerr, 2010). Our third contribution is methodological. Since recipient and non-recipient firms are inherently different, a central issue in the program evaluation literature is the adoption of a strategy that allows the researcher to correctly identify the effect of the policy. In our case we use a sharp regression discontinuity design (Lee and Lemieux, 2010). The program established that only the projects scoring above a certain level on an assessment by a technical committee would be subsidized. In order to evaluate the policy's impact we thus compare the patenting activity of subsidized and unsubsidized firms close to the threshold score.[3] The regional dimension allows us to further reduce the unobserved heterogeneity among enterprises by comparing firms located in the same area and therefore more alike than those participating in nationwide programs. Moreover, our assessment allows us to shed further light on the impact of place-based policies managed by a regional government, which have been little studied to date (Zúñiga-Vicente et al., 2014).[4]

Overall we find that the program increased the number of patent applications submitted by recipient firms, especially smaller ones. The program also appears to have succeeded in increasing the probability of applying for a patent, but only for small enterprises. According to our results, one additional patent application made under the program requires grants of between €206,000 and €310,000 disbursed to the firms by the regional government (the administrative costs of the policy are excluded).

The rest of the paper is organized as follows. In the next section we discuss the theoretical background and the related empirical literature. In Section 3 we illustrate the features of the program. In Section 4 we describe the outcome variables and our dataset. We present the empirical strategy in Section 5 and set out the main results in Section 6. The robustness exercises and concluding remarks make up the final two sections.

2. R&D subsidies and innovation outputs: the theoretical and empirical framework

In theory R&D incentives to private firms are justified by two market failures. It is traditionally argued that the existence of technological spillovers in R&D activity are not taken into account when firms plan their R&D investment (Arrow, 1962). Because of positive spillovers, private investment falls short of the socially optimal level and public support aims to increase the level of R&D investment to bring it closer to the socially optimal equilibrium. Another argument is based on the capital market imperfections that hamper firms' ability to access financing on the markets. This market failure is due to informational asymmetries that are amplified in the case of R&D financing because innovative activity is very risky and difficult to evaluate. For these reasons, it is argued that in the case of R&D internal funds are largely preferred to external financing, and small or younger firms in particular might face financing constraints on their R&D activities (Hall and Lerner, 2009). The purpose of public incentives is therefore to provide firms with sufficient funds to implement innovative investment.

The most common forms of public support for private firms' innovation are subsidies or fiscal incentives. Both aim at increasing firms' investment in R&D by reducing the attendant cost, but while grants are assigned only after projects have been evaluated, tax incentives reduce the firms' tax burden automatically (usually according to the amount of the R&D expenditure realized) without any system of assessment. In this respect tax incentives are more neutral than subsidies because they enable firms to take advantage of fiscal subsidies irrespective of the kind of project undertaken.

Widespread public support for innovation has spawned a huge body of empirical papers that have assessed the effects of various types of incentives on business innovation inputs such as R&D expenditure, investment and employment, but the results are rather mixed. For example, in a recent survey, Zúñiga-Vicente et al. (2014) conclude that the effects are very heterogeneous across programs and studies; in another review Becker (2014) remarks that recent papers on tax credit mostly display positive results, especially for small firms that are likely to be more exposed to financial constraints.[5]

Despite such a large body of evidence on the effects on innovation inputs, very few papers have evaluated the effects of firm incentives on innovation outputs (Köhler et al., 2012). This scant attention may at first appear puzzling because innovation outputs probably represent the ultimate aim of public support for private R&D activities designed to boost firms' competitiveness. However, it could be justified by the approach favored by the evaluators, mainly based on the knowledge production function framework, where innovation is considered a function of a set of innovative inputs, such as R&D investment, the number of researchers, or human capital (Griliches, 1990). Following this approach, incentives are supposed to enhance innovation outputs if they affect R&D spending or other quantitative innovative inputs (such as the number of researchers). Therefore, to examine whether the policies raise such inputs it should be sufficient to assess the policy impact on innovation outputs as well. However, there are several ways in which public incentives might increase the level of innovation outputs without raising innovation inputs in quantitative terms. This may occur if the policy affects the choice of the innovative projects to start, keeping R&D spending constant.

[2] For the period 1995–2009 Emilia-Romagna registered an average of more than 160 patents per year per million inhabitants, more than double the Italian average (see: Istat, Indicators for development policies http://www.istat.it/it/archivio/16777, June 2013).

[3] Jacob and Lefgren (2011) use a similar method to estimate the impact of public grants on U.S. researchers' output measured by the number of published articles and citations, and find a limited impact of public support.

[4] In Italy between 2006 and 2011 about €15 billion – almost 40 per cent of the total – was disbursed to firms under these programs. The literature on the impact of placed-based policies for innovation is growing, but it is still rather thin. For example, the effects of some place-based policies recently implemented in Europe to promote clusters of innovative activities are evaluated by Albert et al. (2002) for France, Dohse (2000) for Germany, Viladecans-Marsal and Arauzo-Carod (2012) for Spain, while the effects of placed-based policies in the United States are examined by Moretti and Wilson (2014). On the effects of regional incentives for firms' innovation in Italy, see Gabriele et al. (2007), Corsino et al. (2012), Fantino and Cannone (2013) and Bronzini and Iachini (2014). Of these only Moretti and Wilson (2014) study the effect on innovation outputs.

[5] This evaluation literature includes, among others, Lerner (1999), Busom (2000), Wallsten (2000), Lach (2002), Almus and Czarnitzki (2003), Gonzalez et al. (2005), Görg and Strobl (2007), Merito et al. (2007), Hussinger (2008), Clausen (2009), de Blasio et al. (2011), Link and Scott (2013), Takalo et al. (2013), Bronzini and Iachini (2014), Einiö (2014), and Moretti and Wilson (2014).